DEVELOP National Program

Program Overview & Wildfire Applications

March 1st, 2017

What is DEVELOP?

NASA Applied Sciences' program that **collaborates** with **decision makers** to conduct environmental research projects using **NASA Earth observations.**

DATA

NASA DEVELOP

DEVELOP participants

DECISION MAKERS

DEVELOP bridges the gap between NASA Earth Science and society, building capacity in both its participants and end-user organizations to better prepare them to handle the environmental challenges that face society.

DEVELOP is a dual-capacity building program:
Partners & Participants

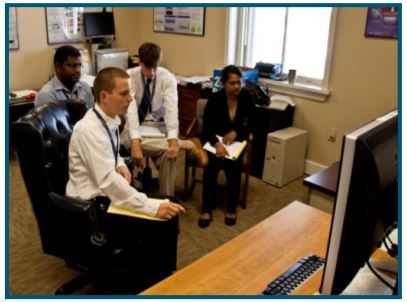
Dual Capacity Building

Participants

Young Professionals, Students & Transitioning Career Professionals

Scientific/Professional Development:

- Experience using NASA Earth observations
- GIS and Remote Sensing
- Working in a group environment
- Management and leadership skills



Personal Development:

- Presentation and communication skills
- Personality typing and working with diverse groups (How NASA Builds Teams)

Professional Networking:

- NASA scientists and managers
- Partner organizations
- Peers – teams, center, and national

End-User Organizations

Local, State, Regional, Federal, Academic, International, and NGOs that participate virtually with DEVELOP teams

Scientific/Professional Development:

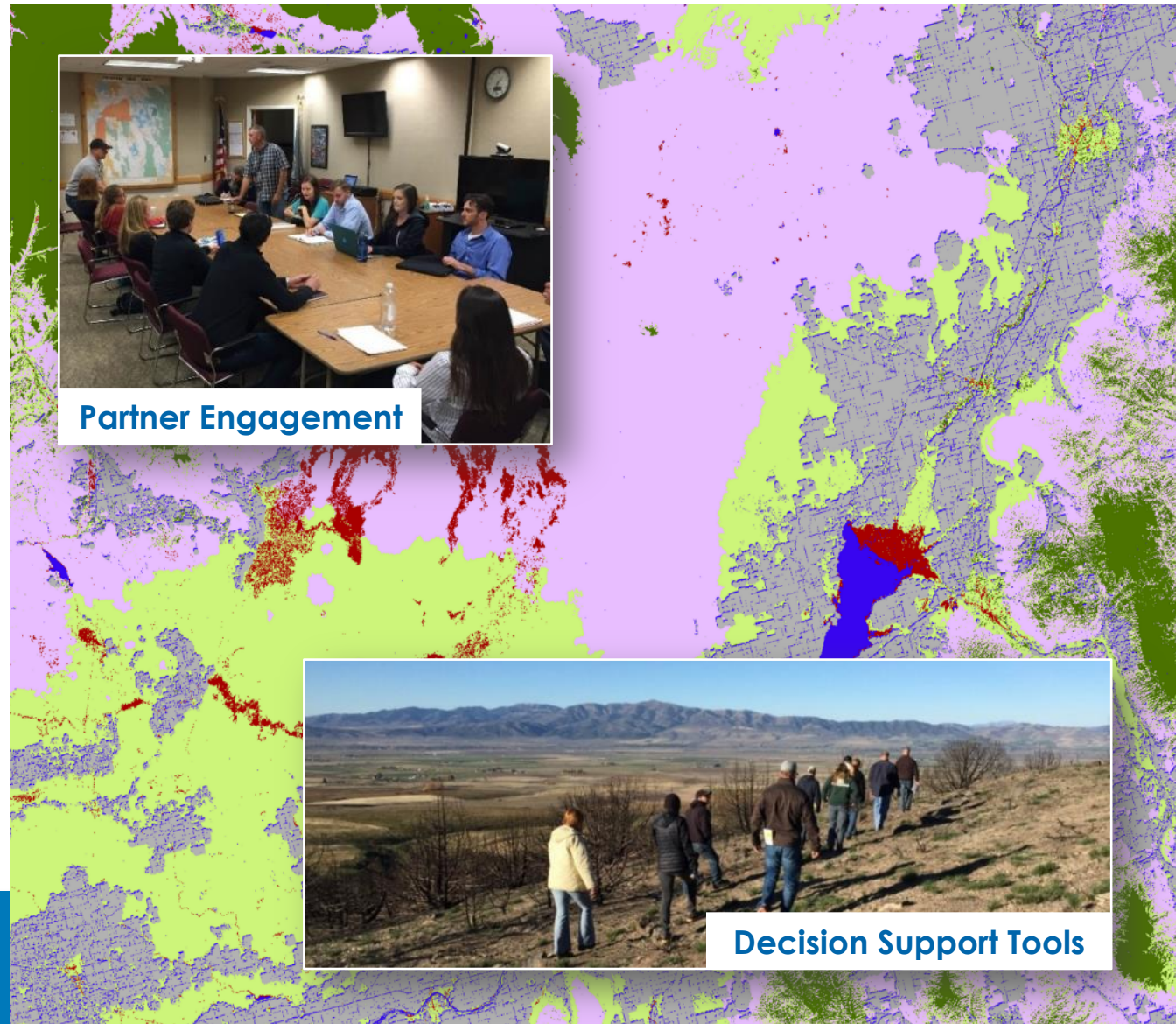
- Introduction to NASA's Applied Sciences Program and its contributions to society

- Introduction to new methods to augment current practices: cost-saving & time-saving

- Enhanced decision support through use of NASA Earth observations

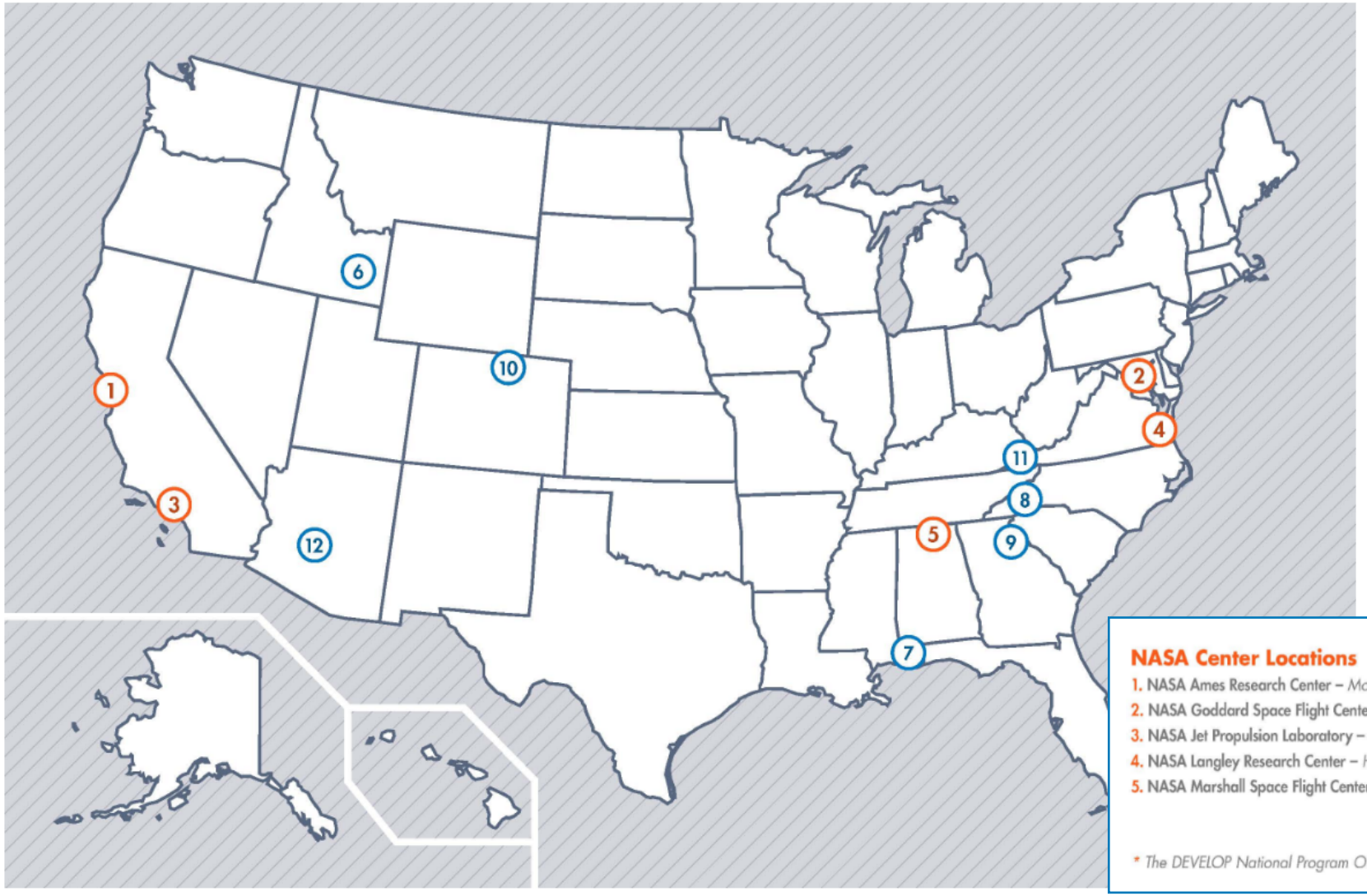
DEVELOP Project Characteristics

- Address ***community concerns*** relating to environmental issues
- ***Collaborate with decision making organizations*** who can benefit from using NASA Earth observations
- Utilize and highlight the **application of NASA Earth observations**
- ***Science advisors and mentors*** from NASA and partner organizations



DEVELOP is rapid feasibility and implementation:
10 Week Long Projects

Where is DEVELOP?



12 DEVELOP Nodes

- Presently only in the United States
- 12 Offices
- 5 @ NASA Centers
- 7 @ Regional Partner Organizations

NASA Center Locations

1. NASA Ames Research Center – *Moffett Field, CA*
2. NASA Goddard Space Flight Center – *Greenbelt, MD*
3. NASA Jet Propulsion Laboratory – *Pasadena, CA*
4. NASA Langley Research Center – *Hampton, VA**
5. NASA Marshall Space Flight Center at NSSTC – *Huntsville, AL*

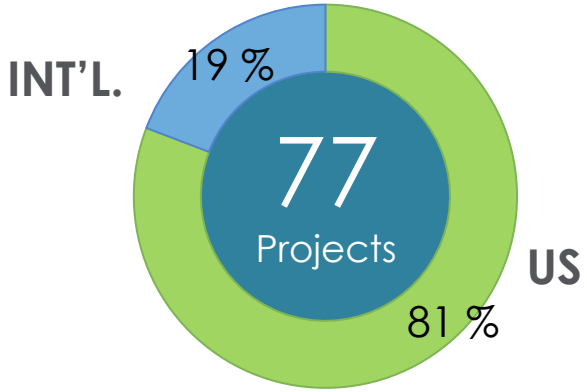
* *The DEVELOP National Program Office is located at Langley.*

Regional Locations

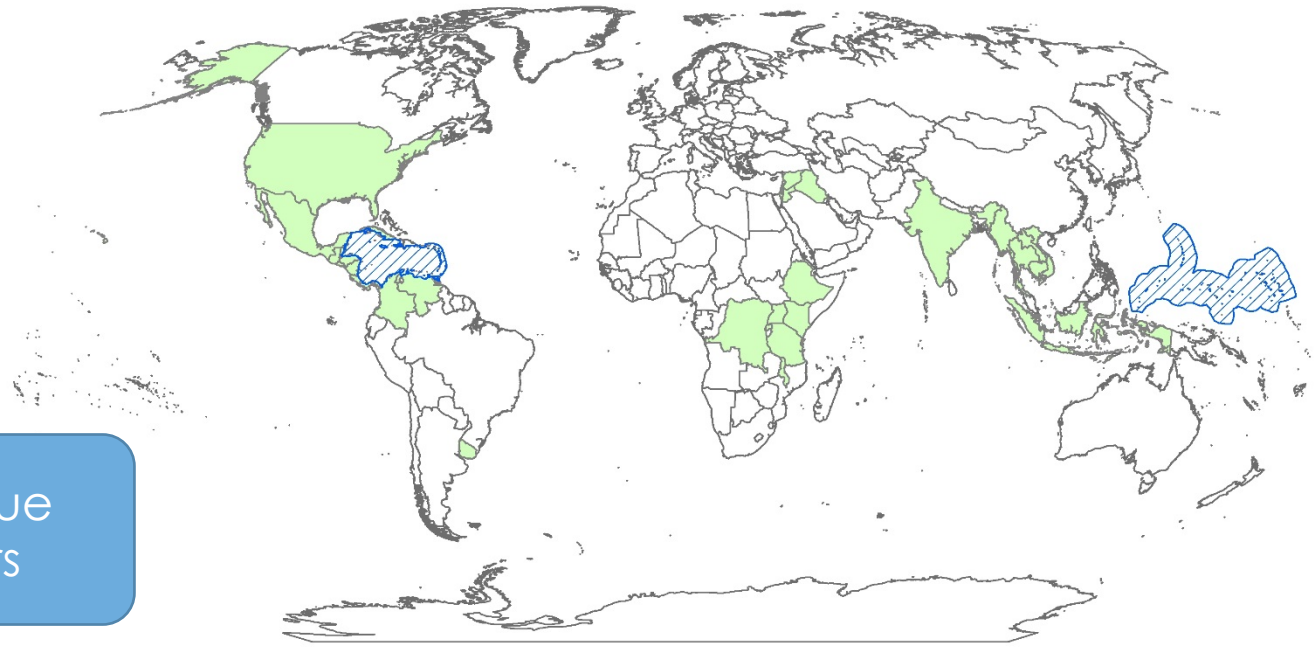
6. BLM at Idaho State University GIS TReC – *Pocatello, ID*
7. Mobile County Health Department – *Mobile, AL*
8. NOAA National Centers for Environmental Information – *Asheville, NC*
9. University of Georgia – *Athens, GA*
10. USGS at Colorado State University – *Fort Collins, CO*
11. Wise County and City of Norton Clerk of Court's Office – *Wise, VA*
12. Maricopa County Department of Public Health and Arizona State University – *Tempe, AZ*

DEVELOP Impacts: 2016

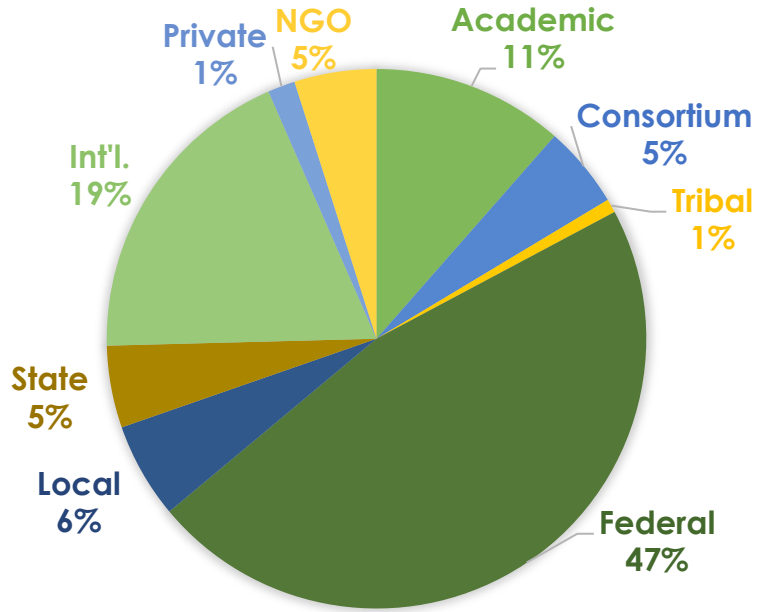
283 total participants



2016 Global Impact : World Regions

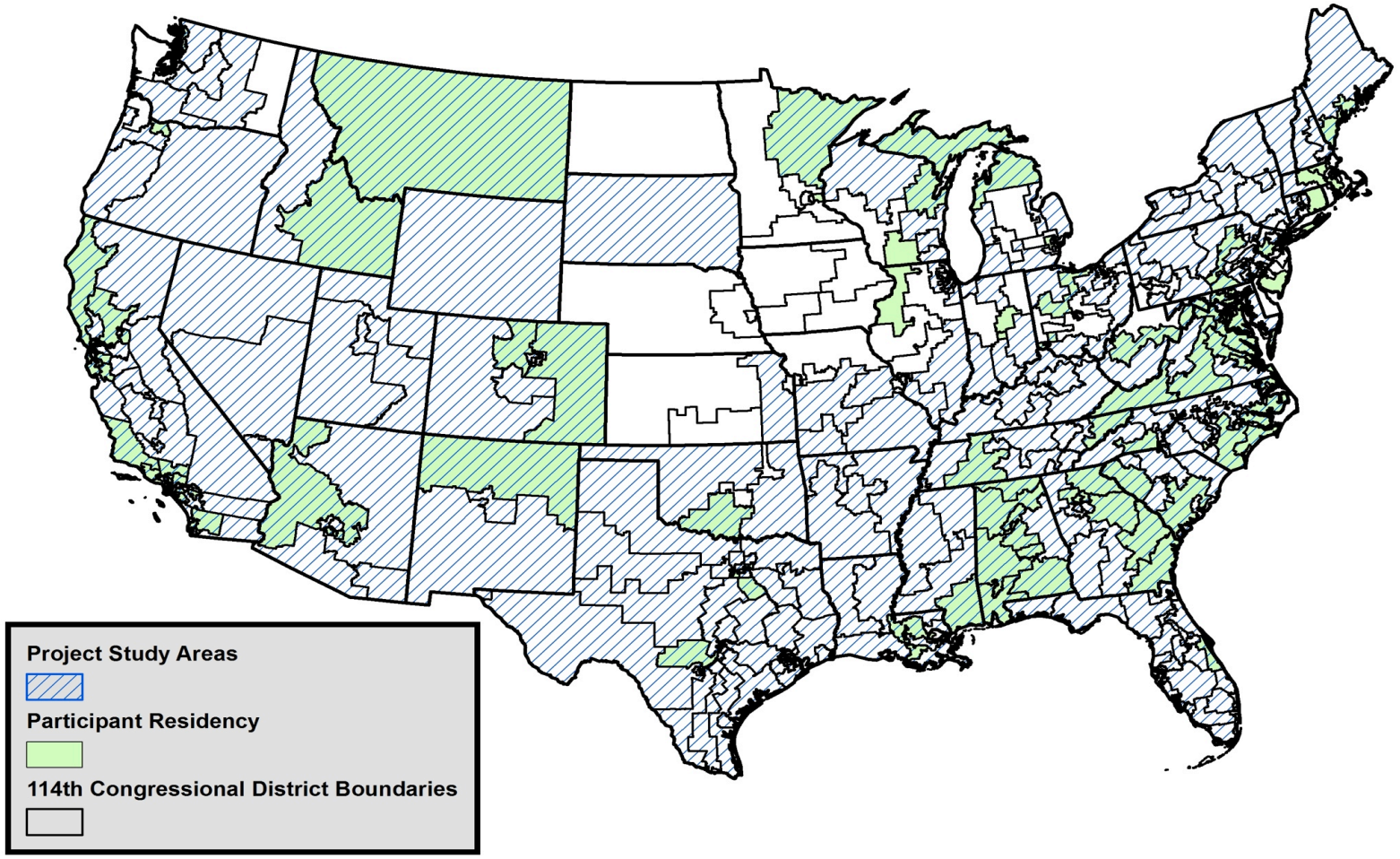


CY 2016 END-USER & PARTNER TYPES



125 unique partners

2016 Impact by Congressional District



Get Involved

1) Propose a project

- Identify a need and end-user for a DEVELOP project.
- Template available for project proposal

Project Considerations

- Achievable with NASA Earth observing resources over a 10 to 30-week period
- Addresses an actionable community concern
- Robust communication with end-user (decision makers)
- Specific study region rather than a large area
- Expectations on both sides are clear
- Additional information regarding partnering with DEVELOP and the project request form can be found at:

• http://develop.larc.nasa.gov/partners.html

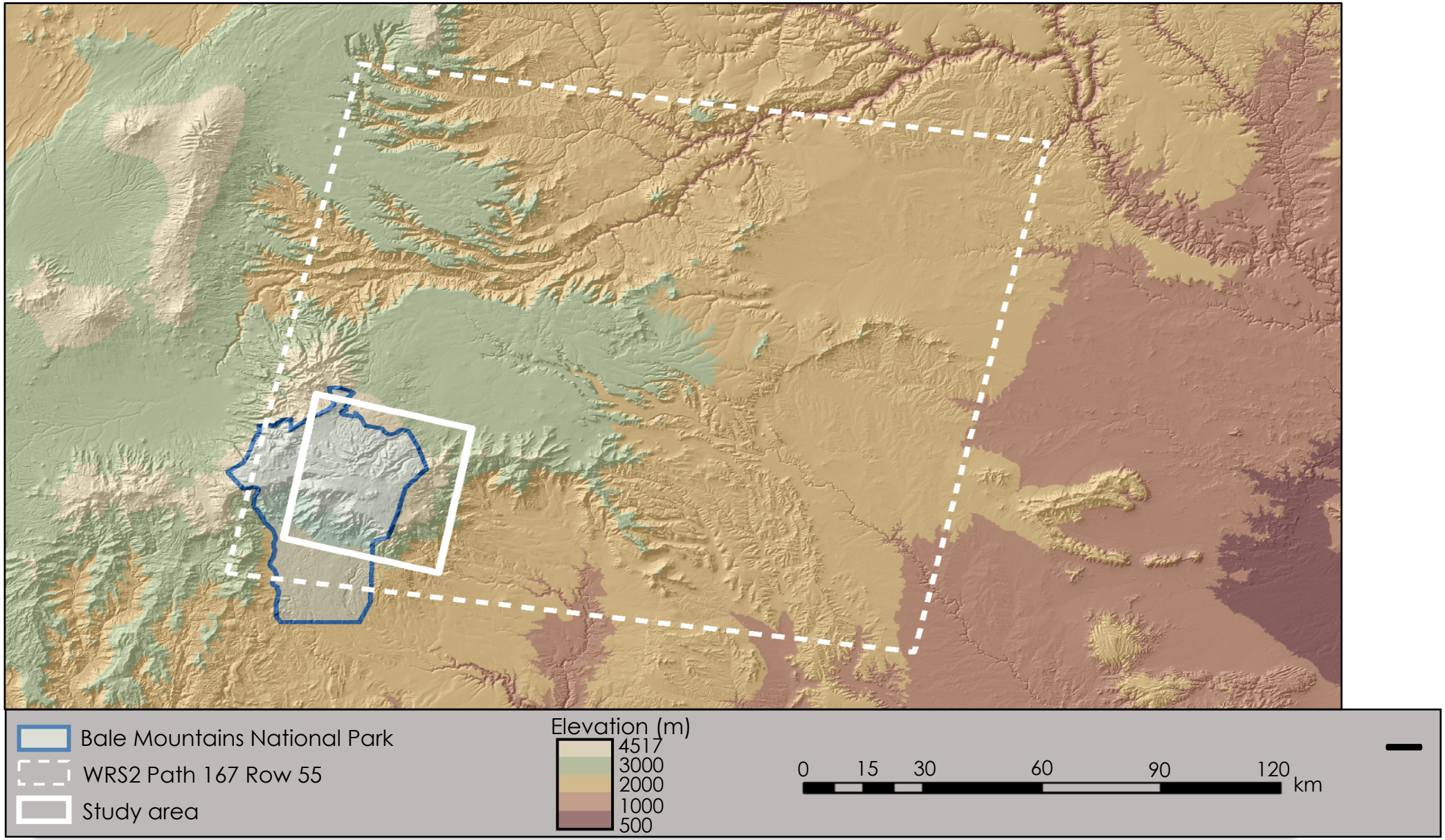
Operations Lead: Lauren Childs- Gleason
lauren.m.childs@nasa.gov

Ethiopia Ecological Forecasting

Mapping four decades of fire history for targeted conservation in the south-central highlands of Ethiopia

Stephen Chignell (Project Lead)
Kelly Hopping
Chandra Fowler
Darin Schulte

Bale-Arsi Massif, Ethiopia



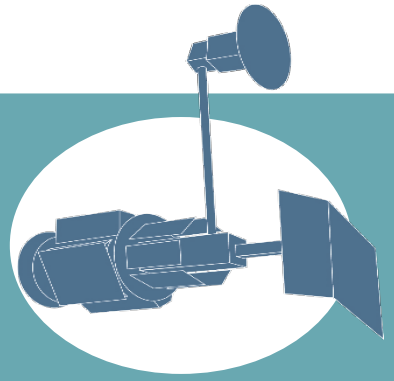
Objectives

- **Quantify** fire extent and distribution on the Bale-Arsi massif over a 42-year time period
- **Provide** land managers with the most current and complete record of fires in the region

- **Compare** patterns of burning to observed land changes
- **Demonstrate** a reproducible methodology

Image Credits: Stephen Chignell

Work flow

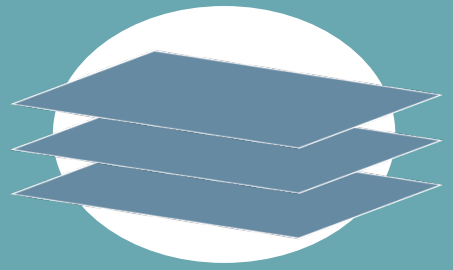


Data Acquisition

MSS, SRTM
TM, ETM+

OLI

MODIS
burned area



Data Processing

LandsatLinkr

Gap-filling &
Normalized
Burn Ratio

Aggregation

Analysis

Tasseled Cap
Compositing

Thresholding

Landsat
Validation

Results

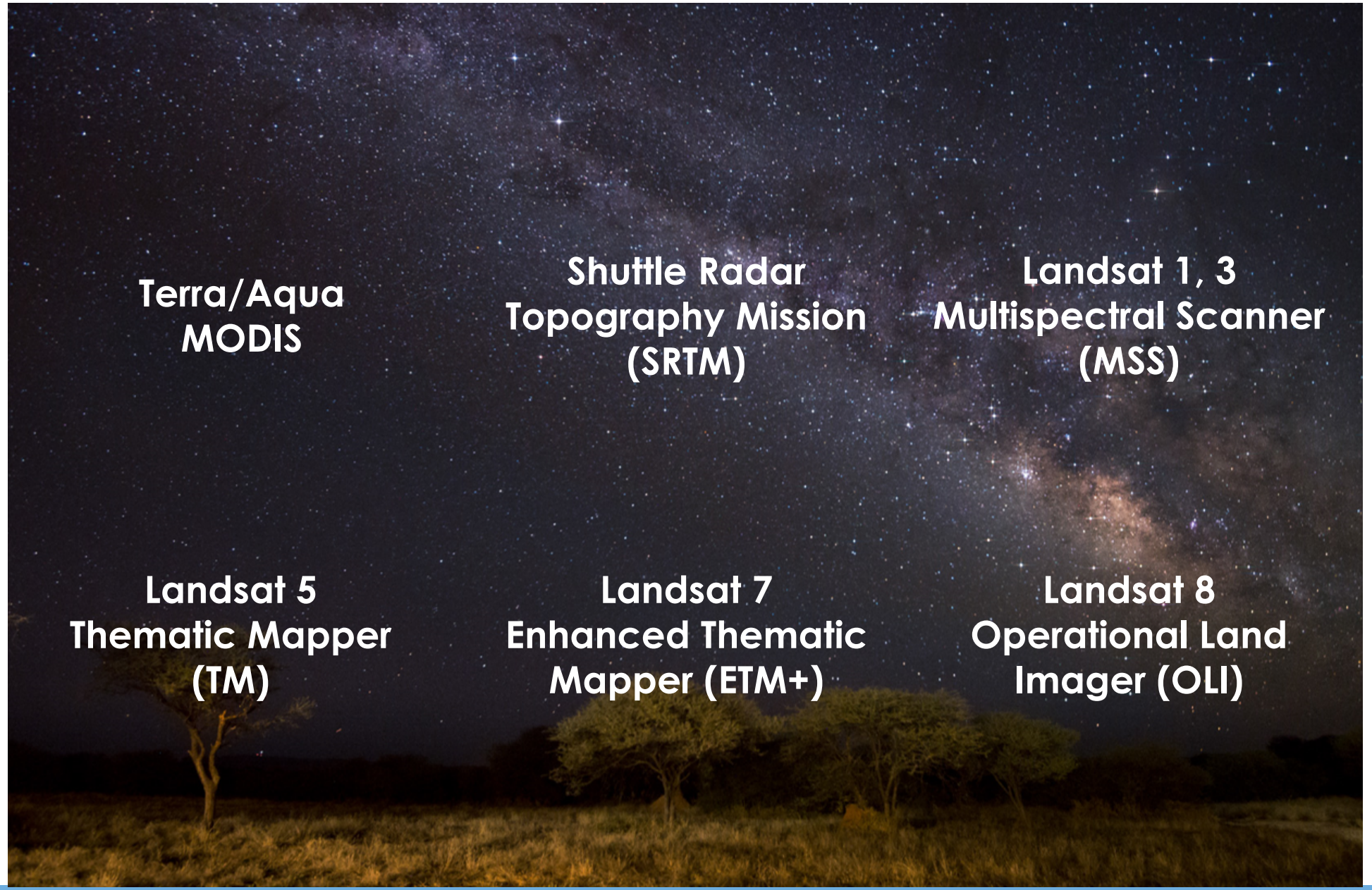
Time Series
Visualization

Fire extent

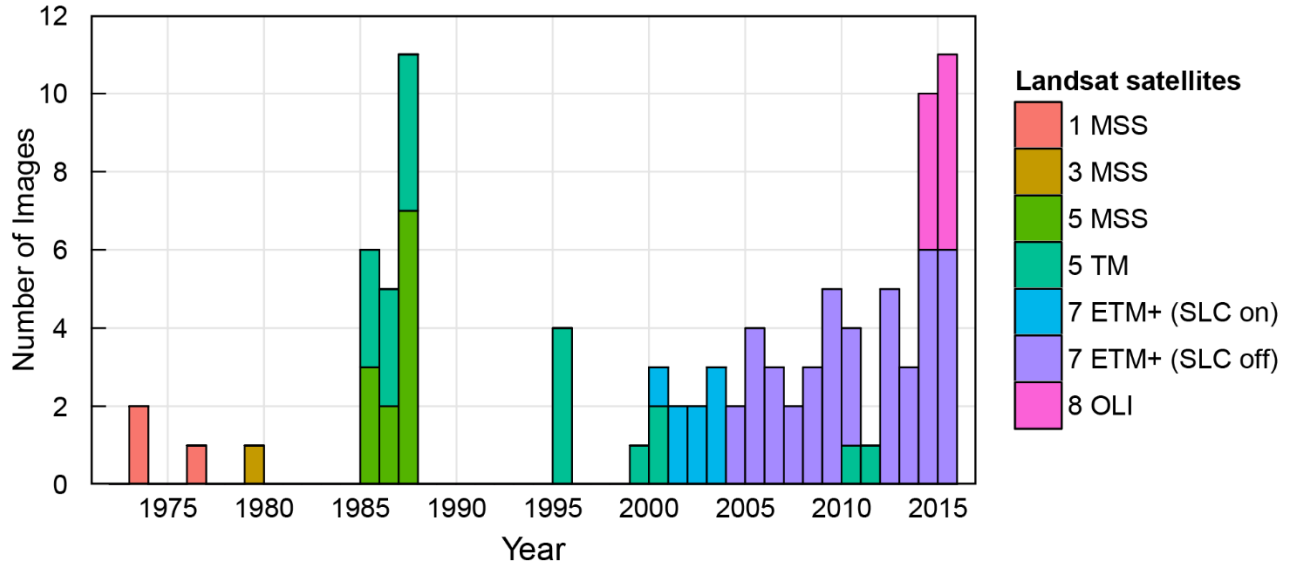
Burn
Frequency

Land Cover
Assessment

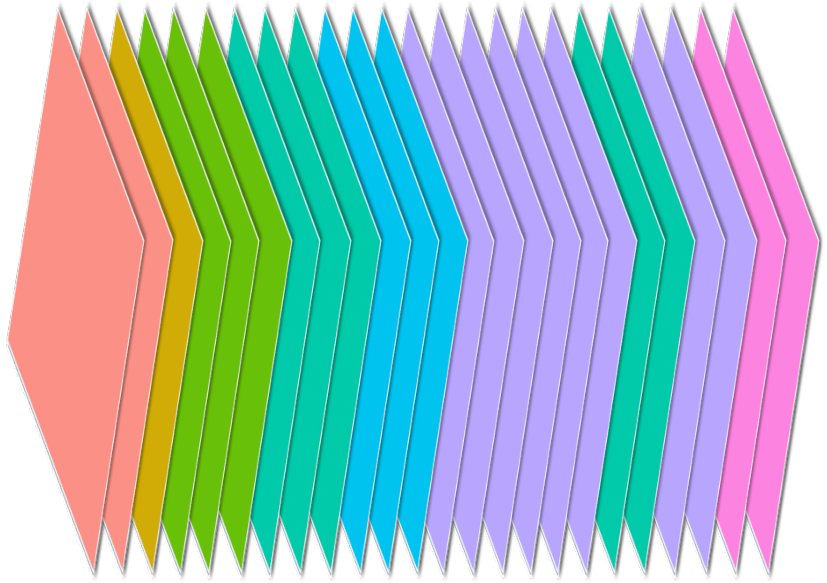
Earth Observations



Data Acquisition & Pre-processing



LandsatLinkr



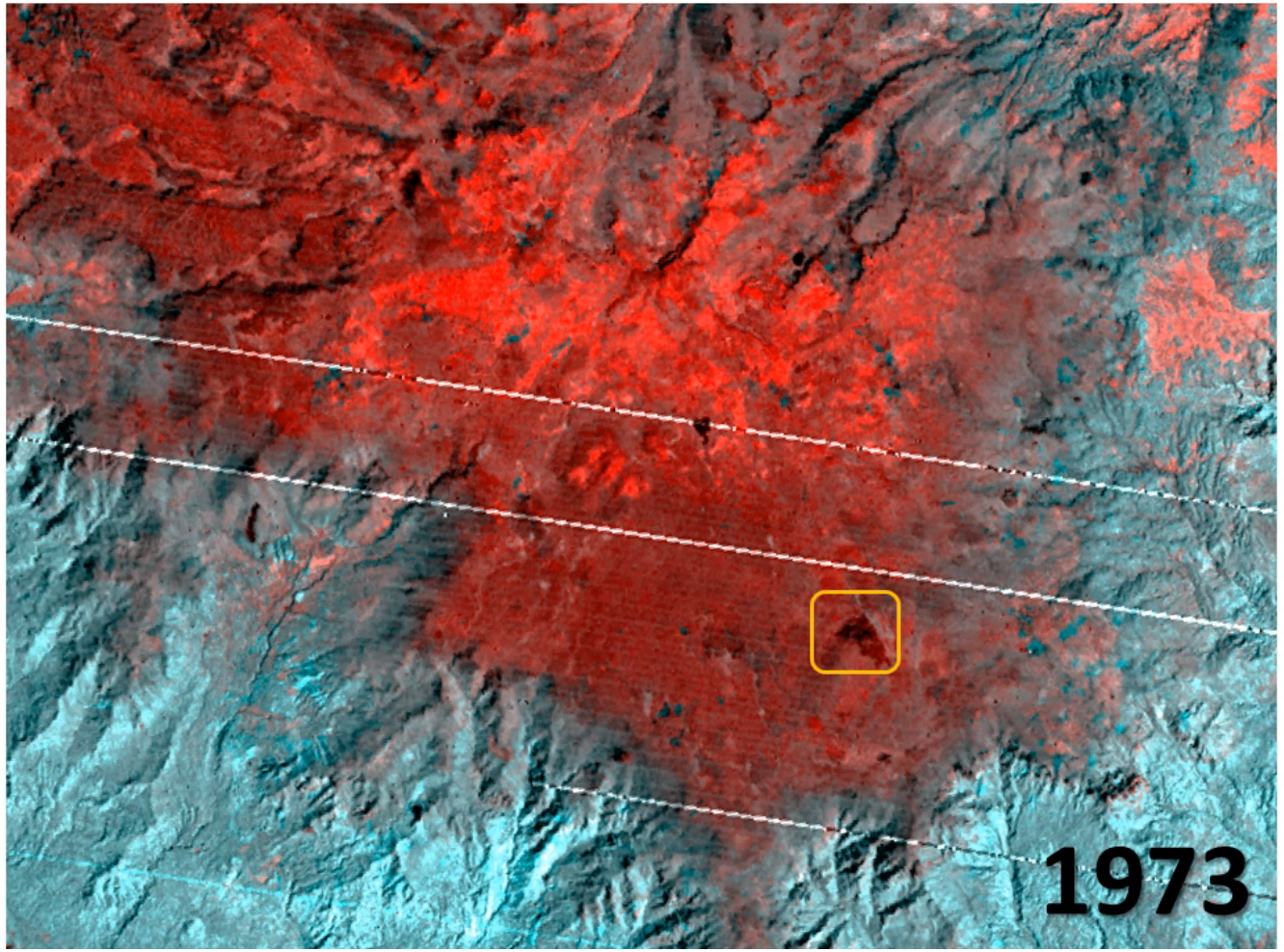
Atmospheric correction

Cloud mask

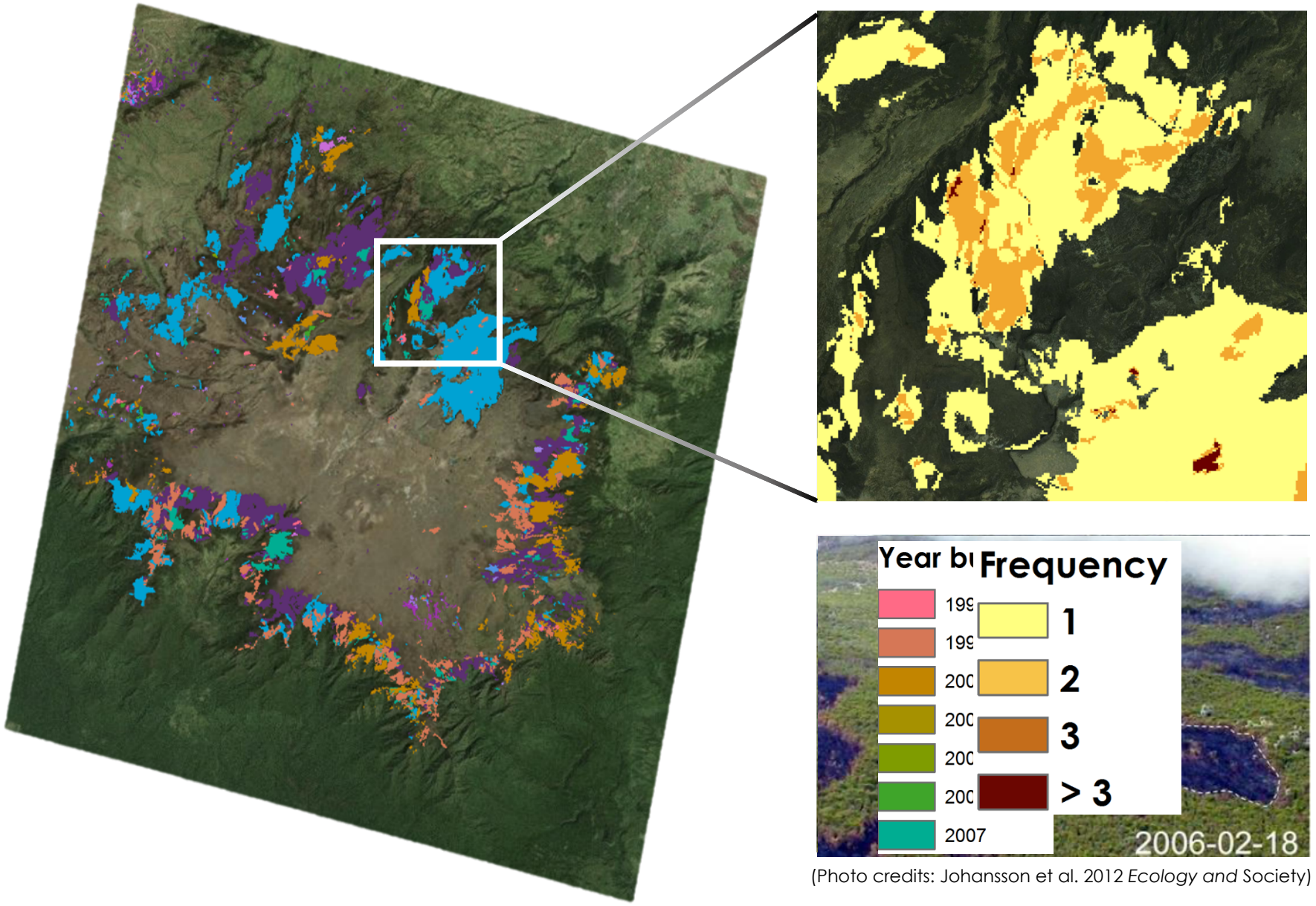
Georegistration

Spectral calibration

Time series visualization

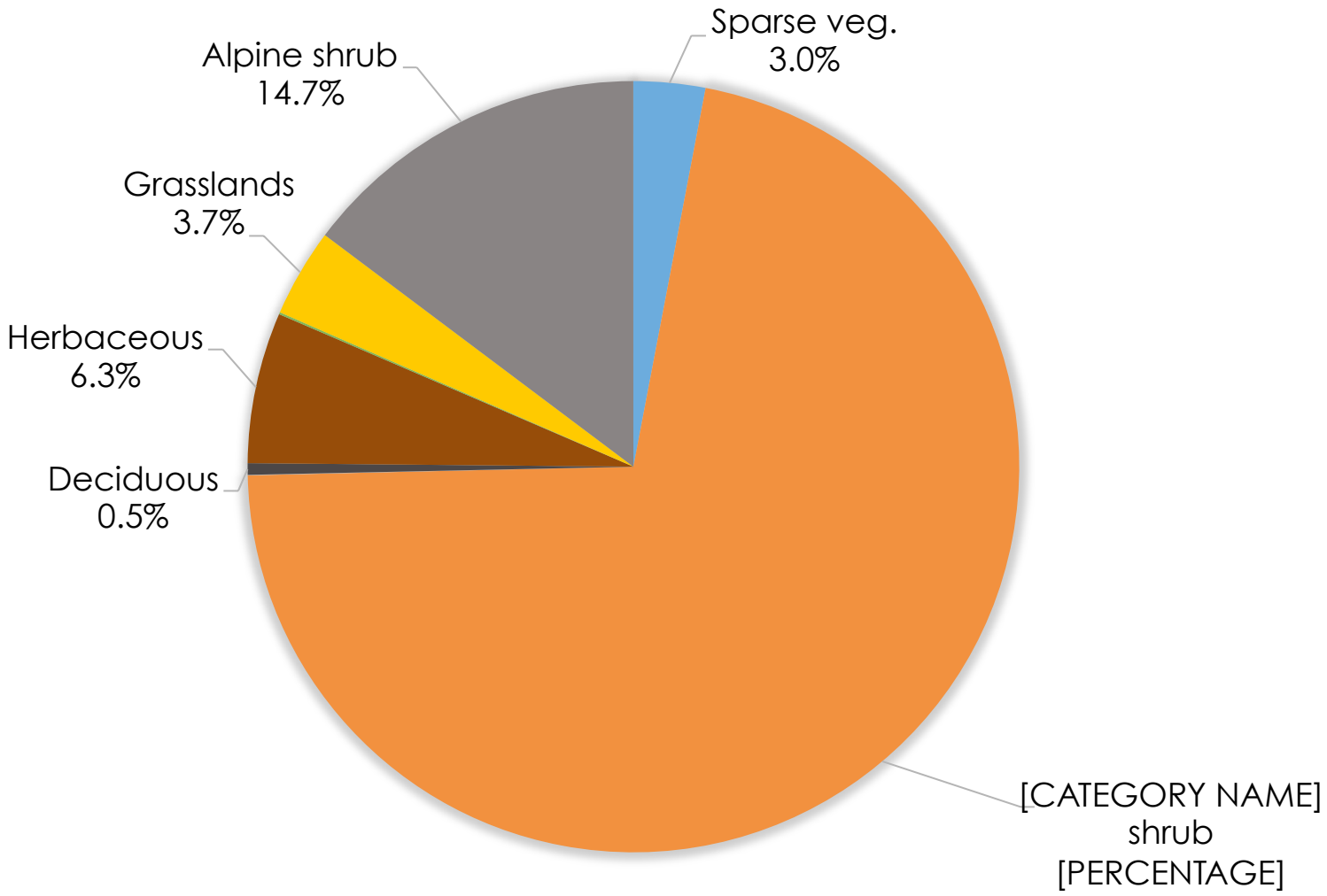


Spatial patterns of burning



(Photo credits: Johansson et al. 2012 *Ecology and* Society)

Vegetation types burned



Wildlife habitat burned

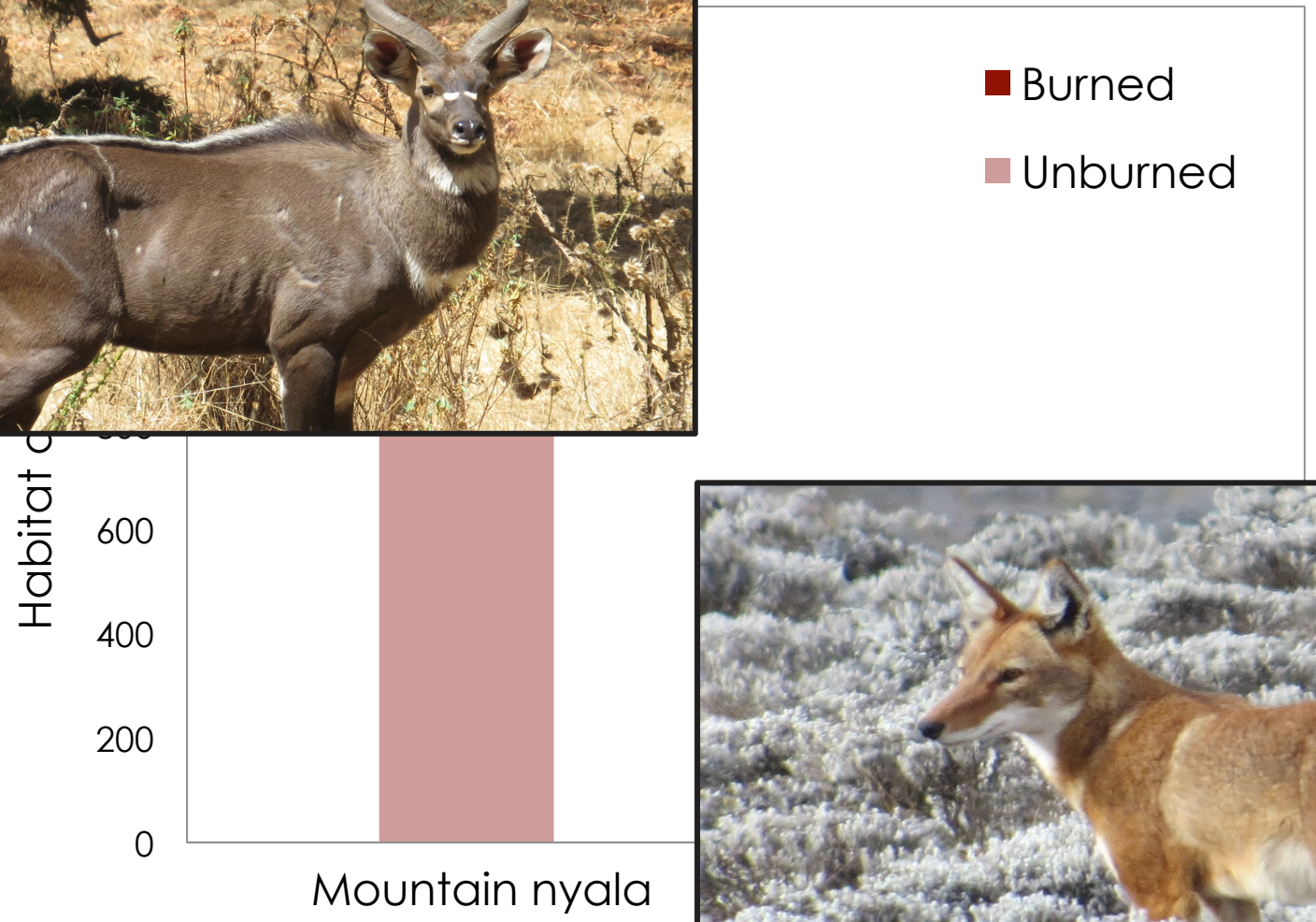


Image Credits: Paul Evangelista

Conclusions

- **35% of ericaceous vegetation burned** in the Bale Mountains between 1995-2015, but **few areas experienced repeated fires**.
- **LandsatLinkr expedites pre-processing**, but data gaps and cloud cover remain challenging for time series analysis in remote, tropical alpine regions.
- **Final products for partners:**
  - Maps and spatial data of fire extent and frequency (1995-2015)
  - Spectrally comparable and composited tasseled cap time series (1973-2015)

Texas Disasters

Utilizing NASA Earth Observations to Assist the Texas Forest Service in Mapping and Analyzing Fuel Loads and Phenology in the Texas Grasslands

Partners: Texas State Forest Service
USDA Forest Service

Ben Beasley
Alex Holland
Kristen Kelehan

Source:"

Community Concerns

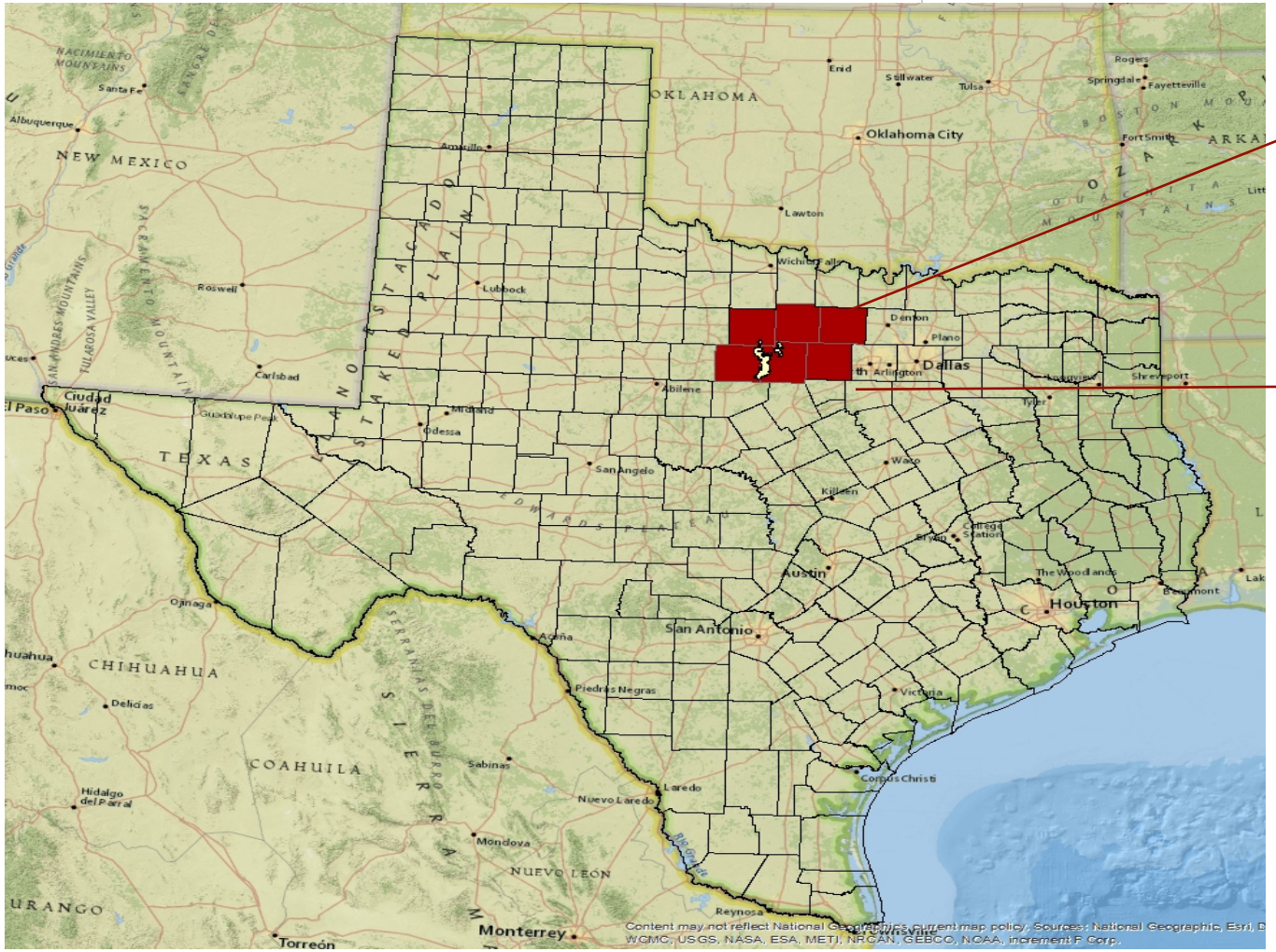
Wildfires risk has increased due to climate change and recent urbanization

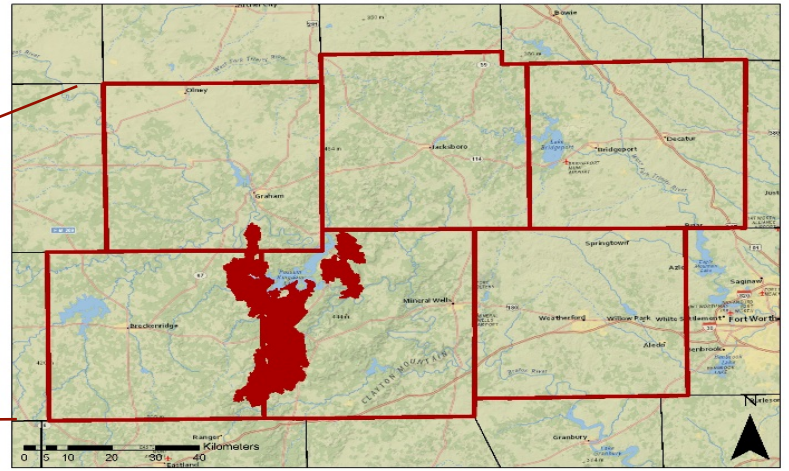
Texas **grasslands** are highly susceptible to wildfires especially during drought years

In 2011 wildfires in Texas scorched **4,000,000 acres** and destroyed nearly **3,000 homes**

Source: NOAA

Study Area





The study covers the State of **Texas** with a case study of the **Possum Kingdom Complex** wildfires which burned approximately 150,000 acres in 2011.

Source: USGS

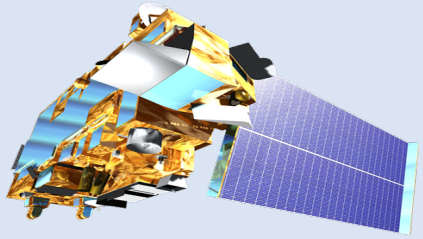
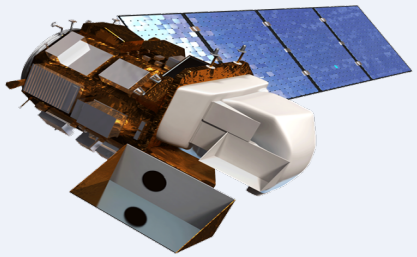
Objectives

Enhance current fuel mapping capabilities using **NASA Earth observation** data

Use and demonstrate NASA data to help assess **seasonal variations** in fuel loads

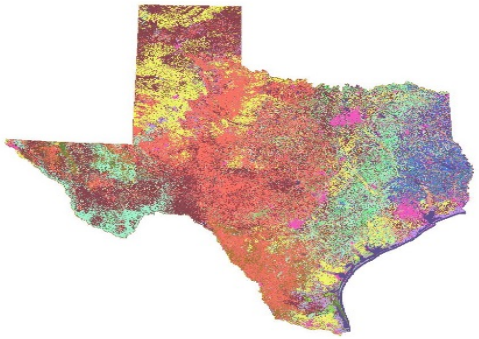
Compile **up-to-date fuel load maps** that depict fuel conditions

NASA Satellites/Sensors

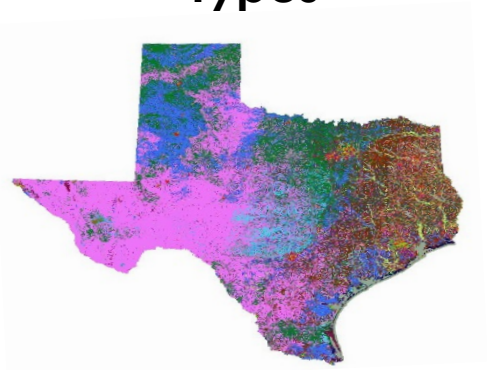
Sensor	Spatial Resolution	Temporal Resolution
MODIS (Terra and Aqua) Moderate Resolution Imaging Spectroradiometer 	**250 m (bands 1-2) 500 m (bands 3-7)** **1000 m (bands 8-36)**	**1 Day**
Landsat 8 OLI Operational Land Imager 	**30 m**	**16 Days**

Methodology

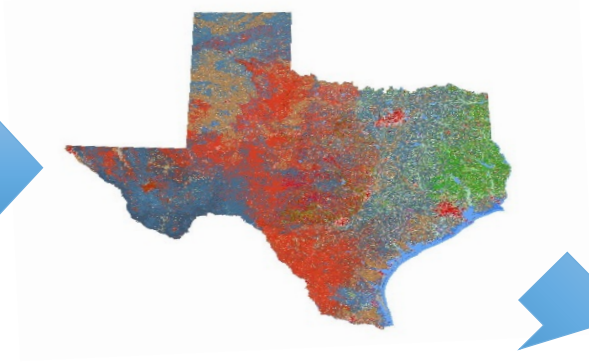
Surface Fuel Types



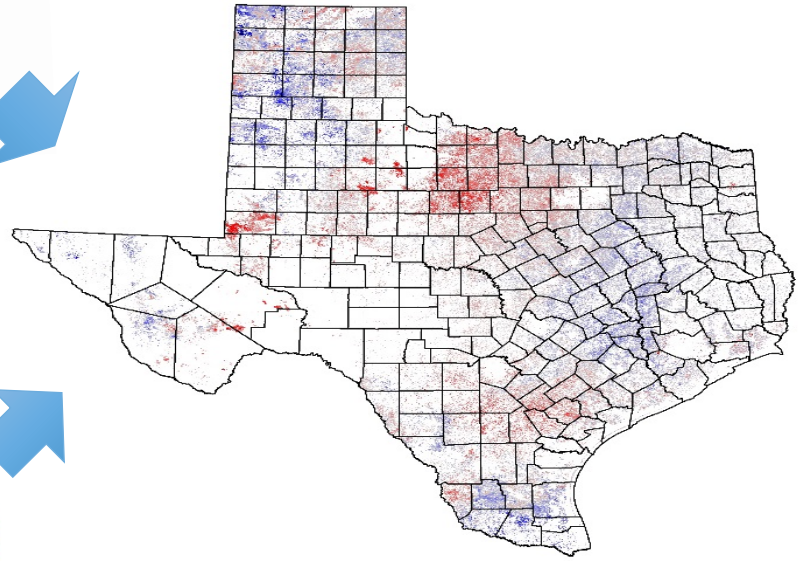
Vegetation Types



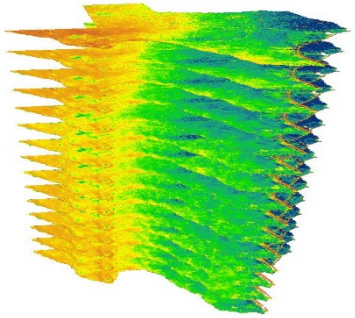
Combined Fuels and Vegetation



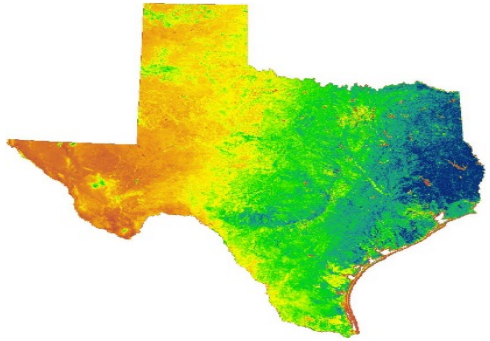
Grassland Annual Relative Fuel Load



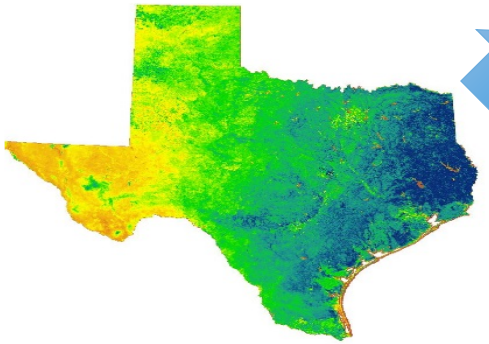
NDVI
2000-2014



NDVI
15 Year Average

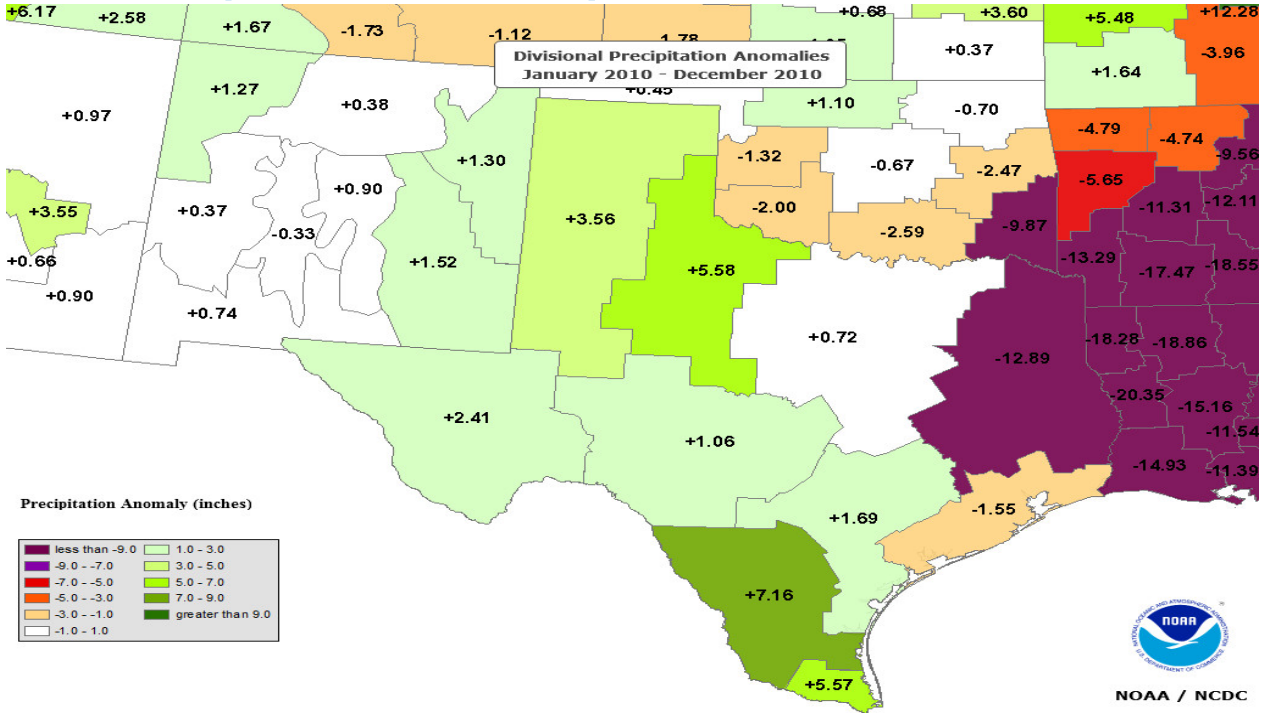


NDVI
Annual

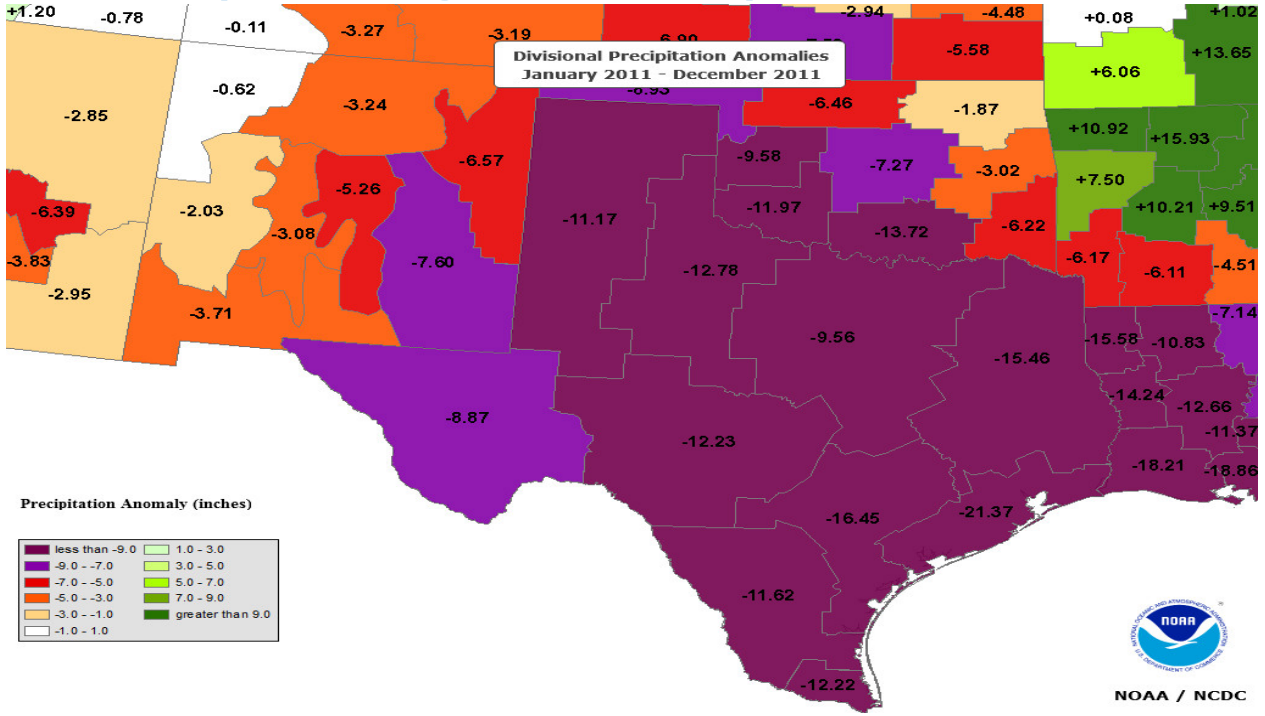


Annual Precipitation

2010 (Wet Year)



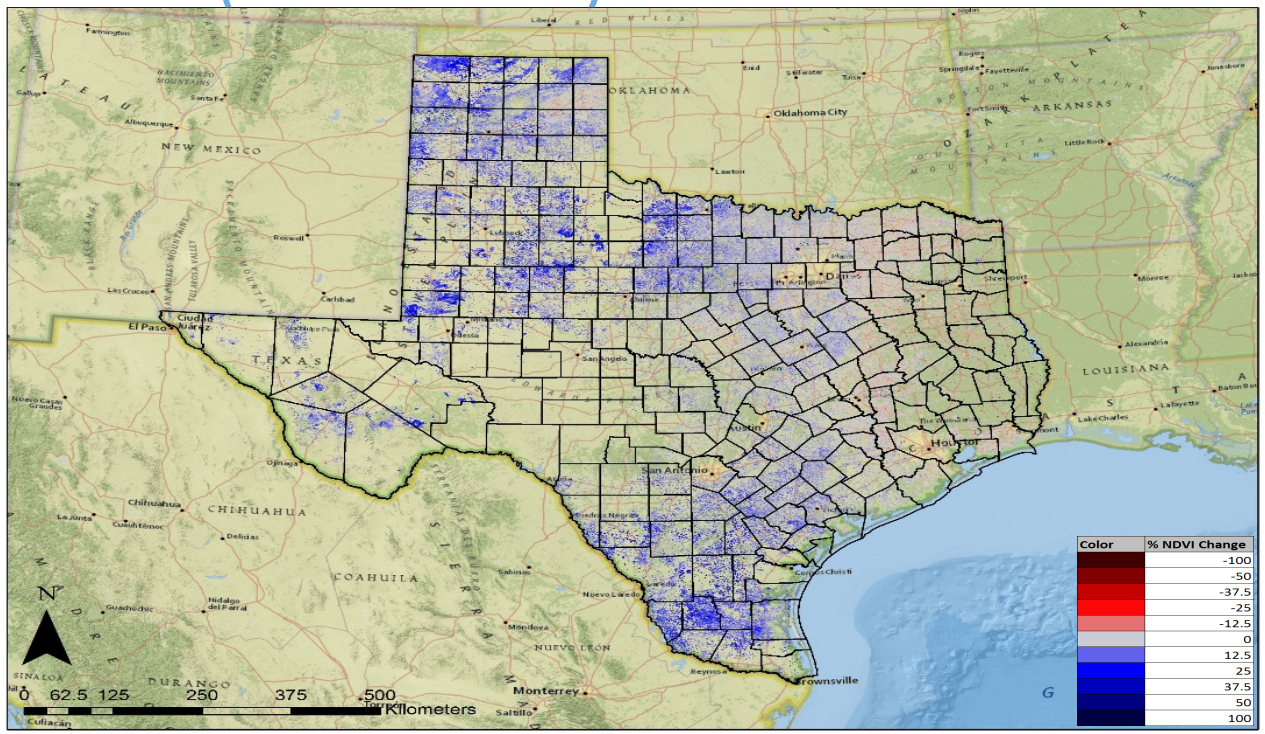
2011 (Drought Year)



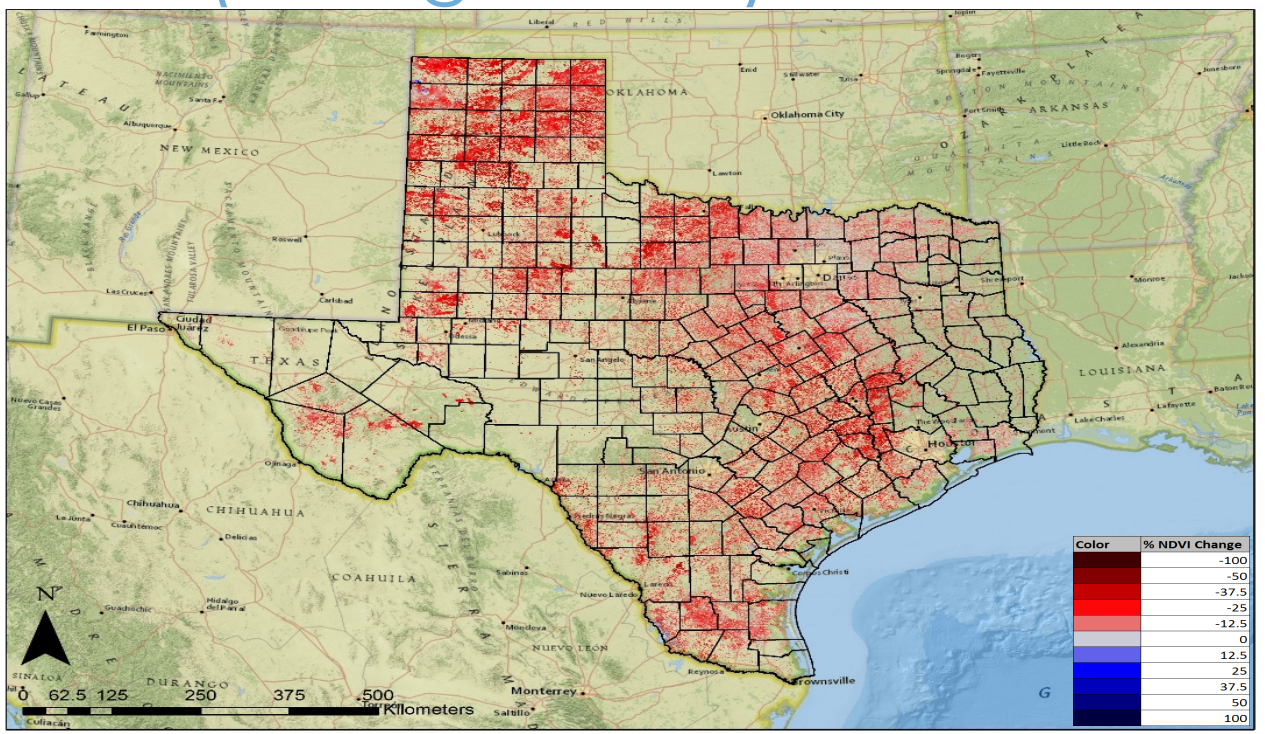
Relative Precipitation – These maps compare the annual precipitation to the average annual precipitation. The green areas depict above average and the red and purple depict areas below average.

Results - Texas

2010 (Wet Year)



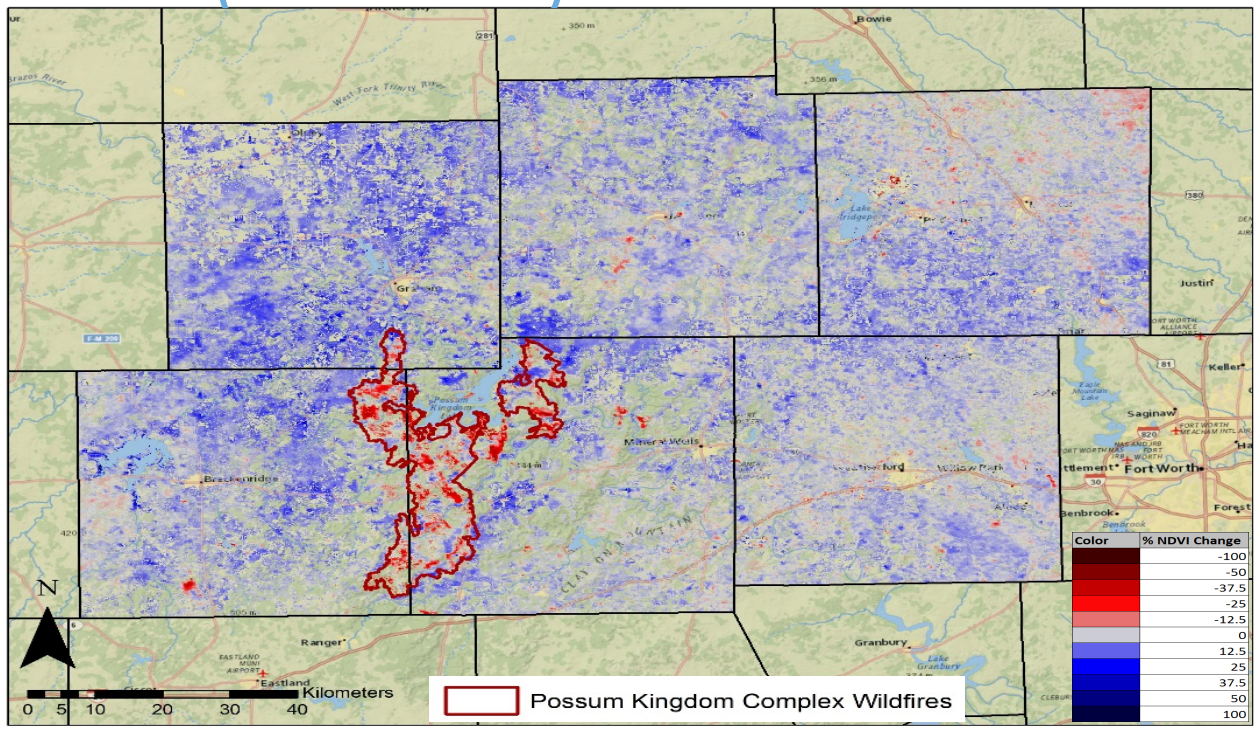
2011 (Drought Year)



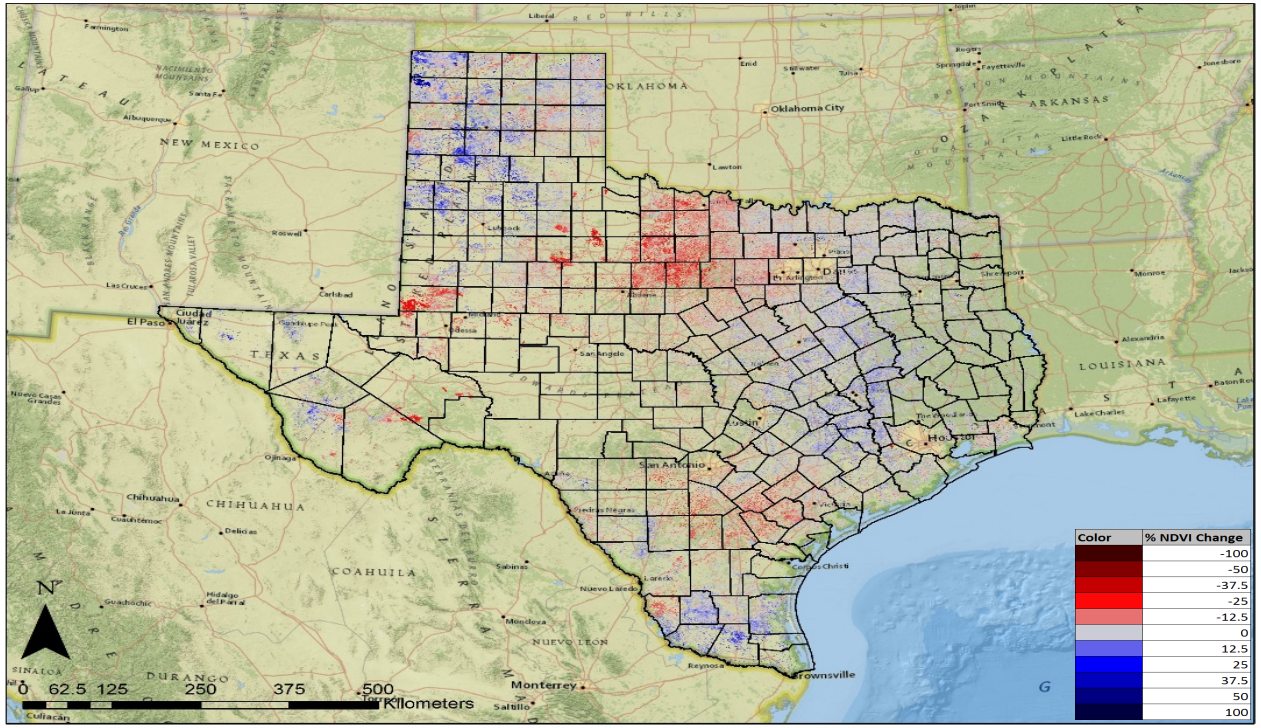
Grassland Relative Fuel Loads – Comparison of annual NDVI to 15 year average NDVI. Bluer areas represent greater than average and redder areas represent less than average NDVI response.

Results

2012 (Post Fire)



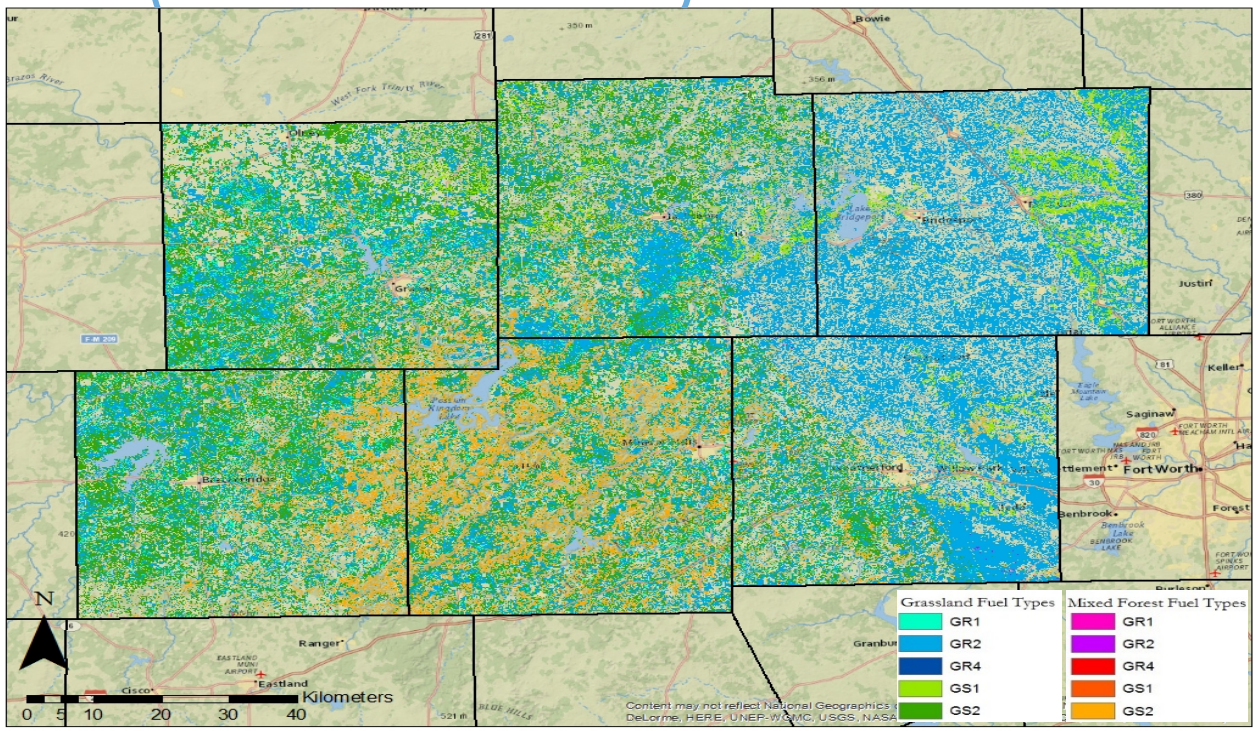
2014



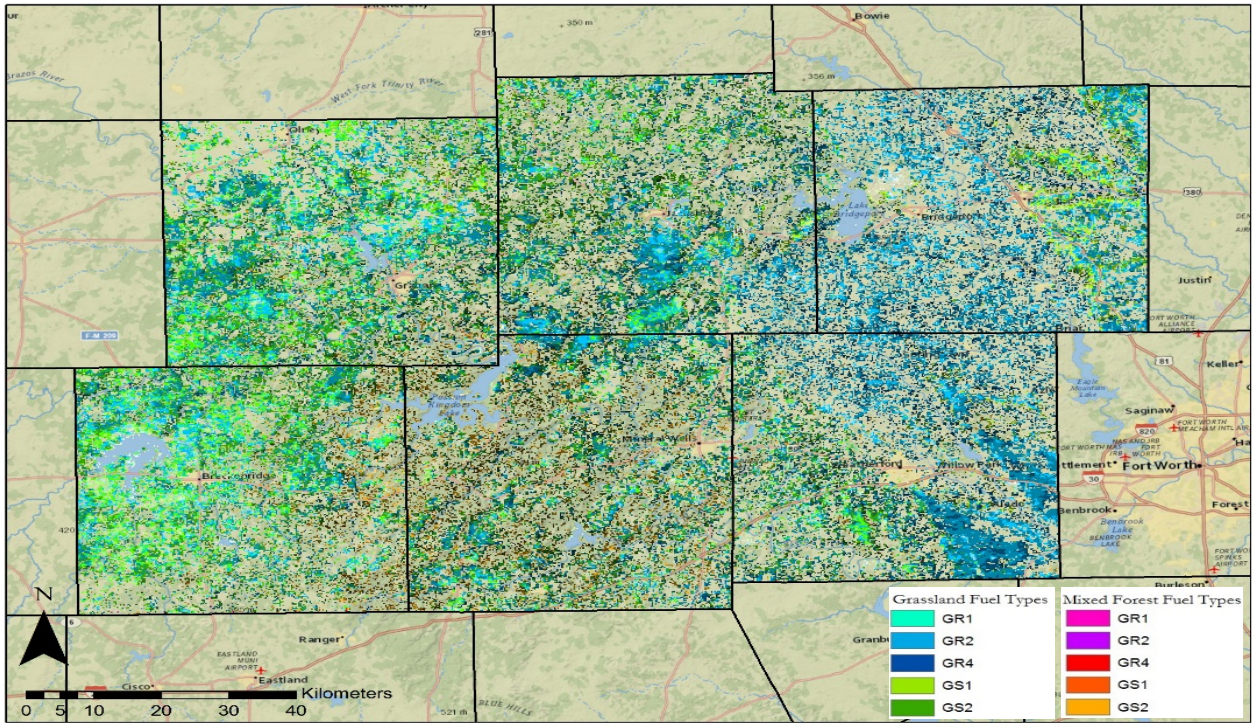
Grassland Relative Fuel Loads – Comparison of annual NDVI to 15 year average NDVI. Bluer areas represent greater than average and redder areas represent less than average NDVI response.

Results

TFS (Surface Fuels)



2014 (Relative Fuels)



Fuel Type Maps – MODIS data was used to calculate zonal mean for each fuel type based on 15 year cumulative annual NDVI. The difference of the 2014 annual NDVI was to show percentage difference from the mean for each fuel type.

Conclusions

Fuel Loads

Geospatial information on grassland **fuel loads** are important for assessing wildfire risk

MODIS NDVI

Annual cumulative **MODIS NDVI** offers a means to monitor relative fuel loads

Fuel Models

Such MODIS NDVI products can serve as inputs to **fuel load models**

Wyoming Ecological Forecasting

Mapping Cheatgrass Phenology and Distribution in a Post-Wildfire Landscape in Wyoming's Medicine Bow National Forest
Fort Collins USGS- CSU Fall 2015

Darin Schulte(Project Lead)

Stephanie Krail

Chandra Fowler

Oliver Miltenberger

End-users:
Wyoming Game and Fish Department
USDA Forest Service, Laramie District

Collaborators:
Natural Resource Ecology Laboratory, Colorado State University

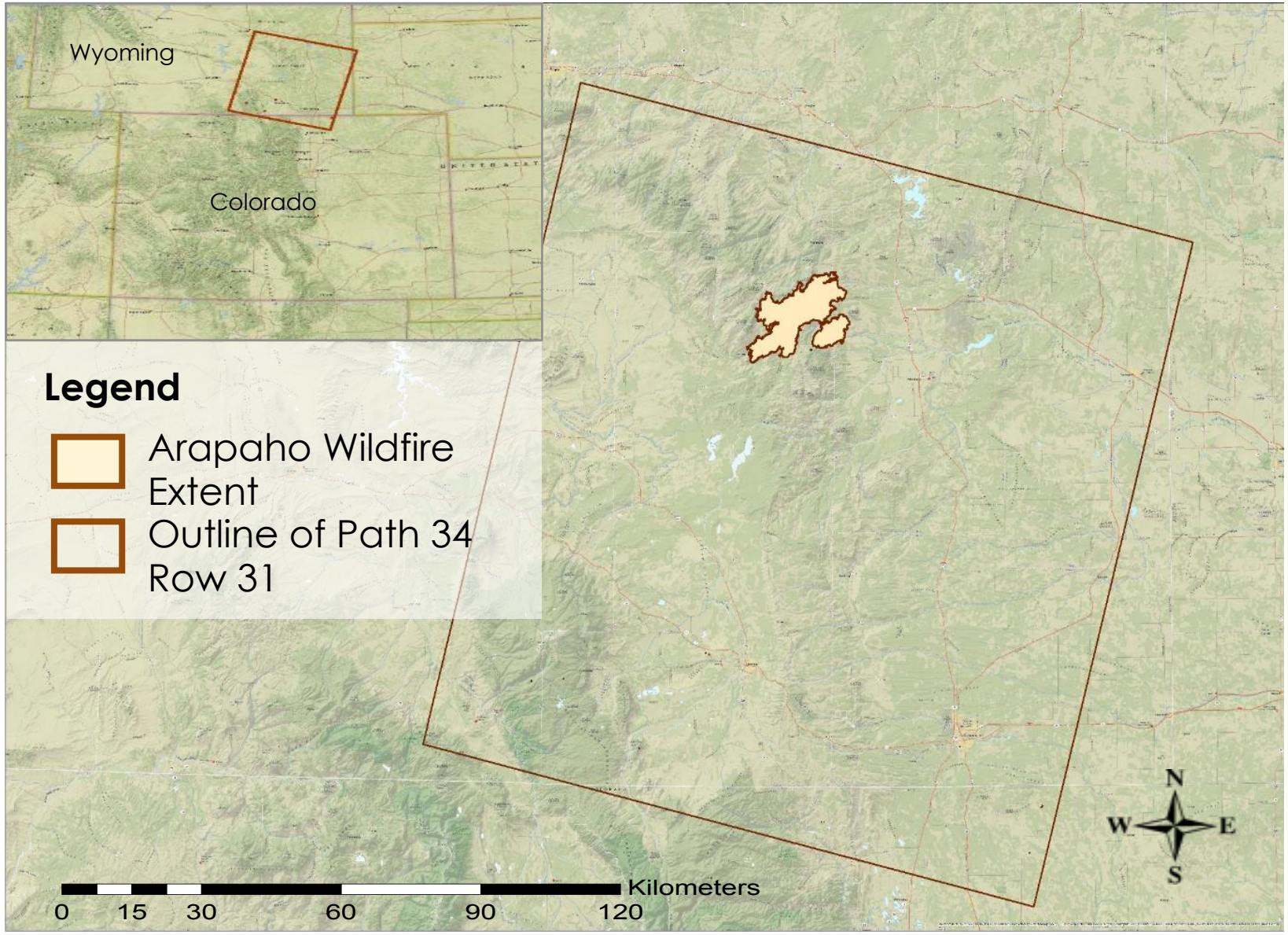
Community Concerns & Objectives

- Cheatgrass is a problematic **invasive** species
- 2012 **Arapaho wildfire** in the Medicine Bow National Forest, WY
- **Expensive & labor intensive** mitigation
- Accurate maps needed for **targeted management**

- Utilize a Species Distribution Models (SDMs) to **map cheatgrass cover**
- Assess **phenological characteristics** of areas with predicted cheatgrass cover
- Inform **targeted mitigation** of cheatgrass populations for project partners

Arapaho Wildfire site 2015

Study Area

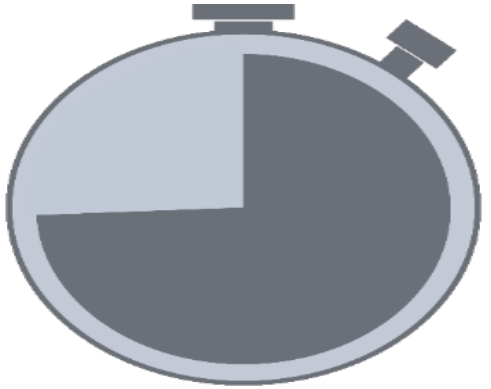

Wyoming
Colorado
Legend
Arapaho Wildfire Extent
Outline of Path 34 Row 31
N
W
E
S
Kilometers
0
15
30
60
90
120

Data Processing

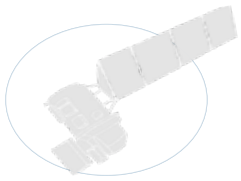
Vegetation indices

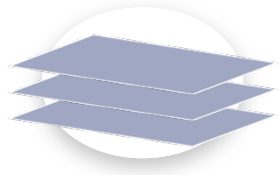
Topographic indices

Presence / Absence



Phenology time series





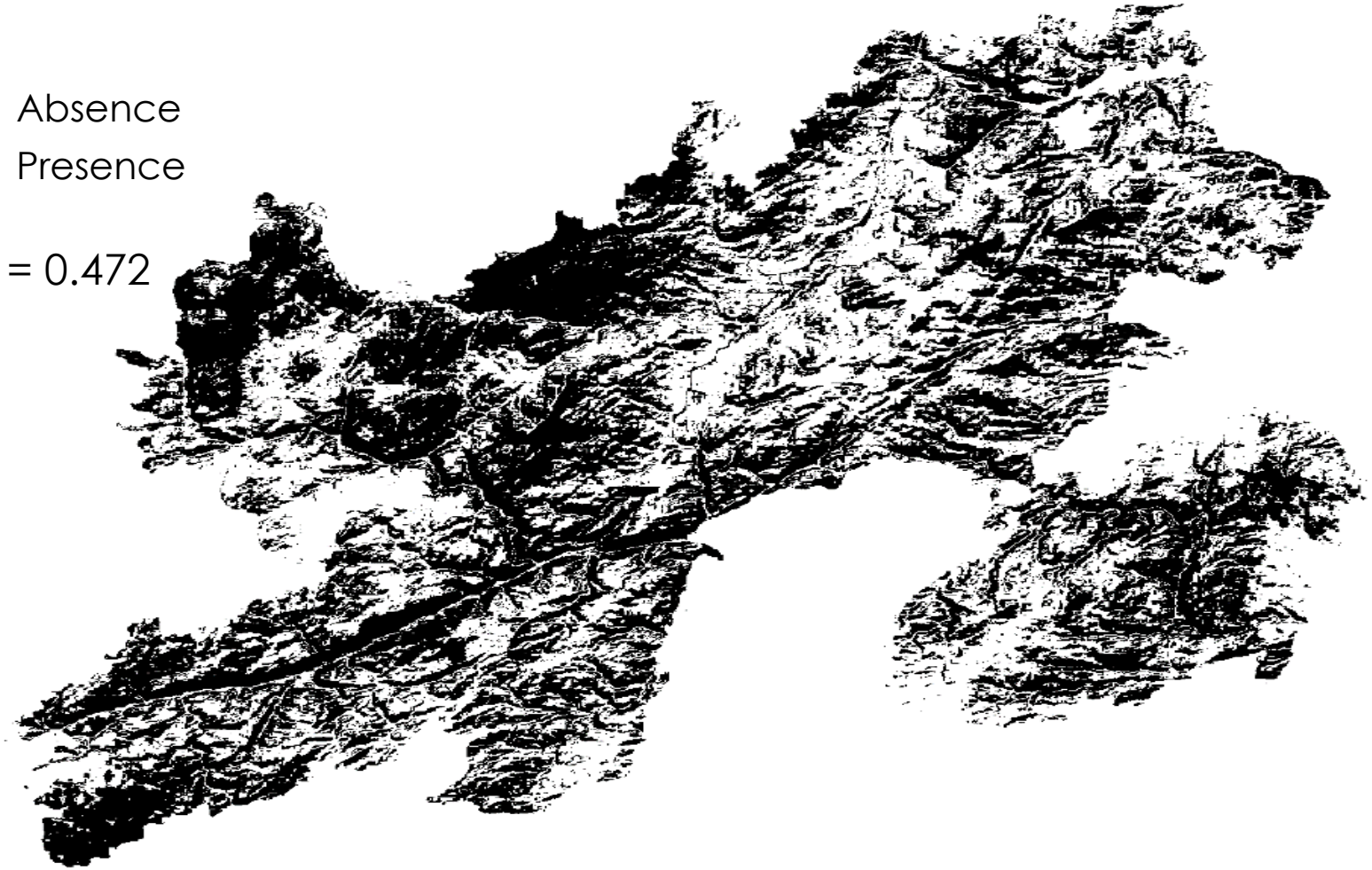
Results

Legend

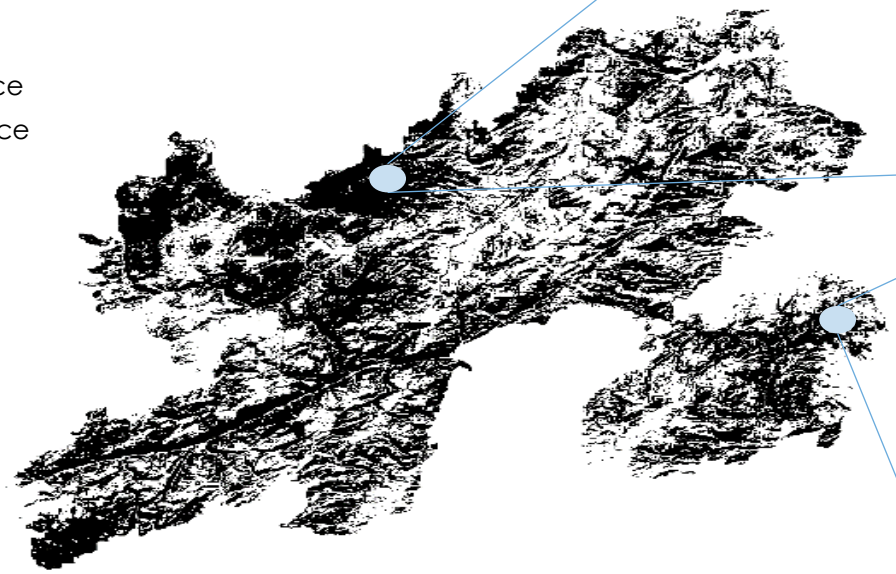
Absence

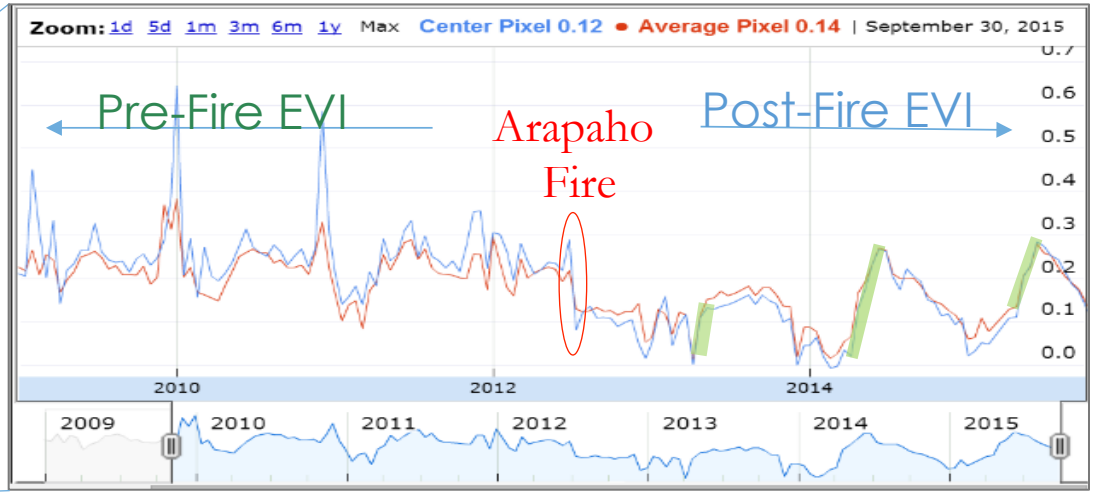
Presence

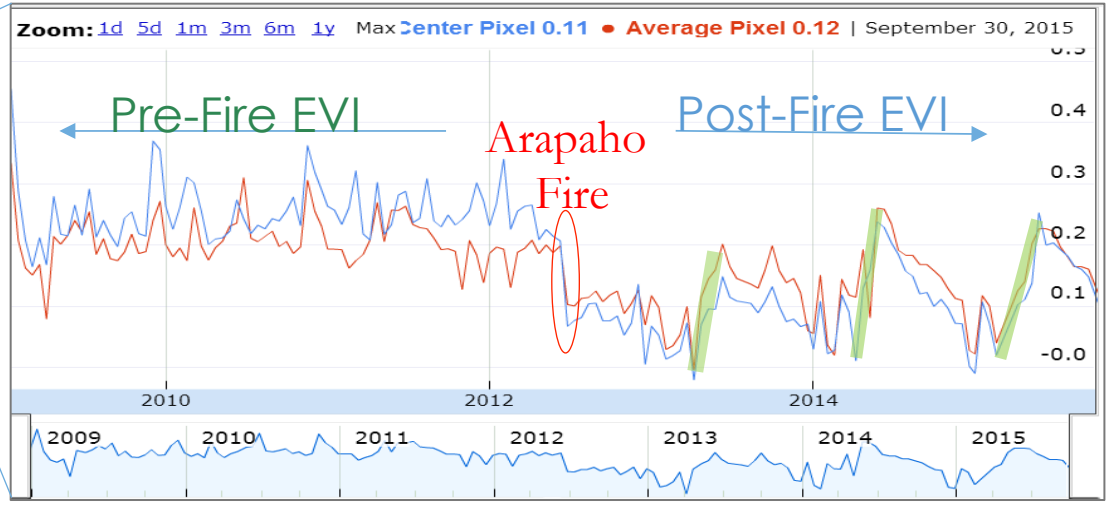
Presence threshold = 0.472



Results


Legend
Absence
Presence

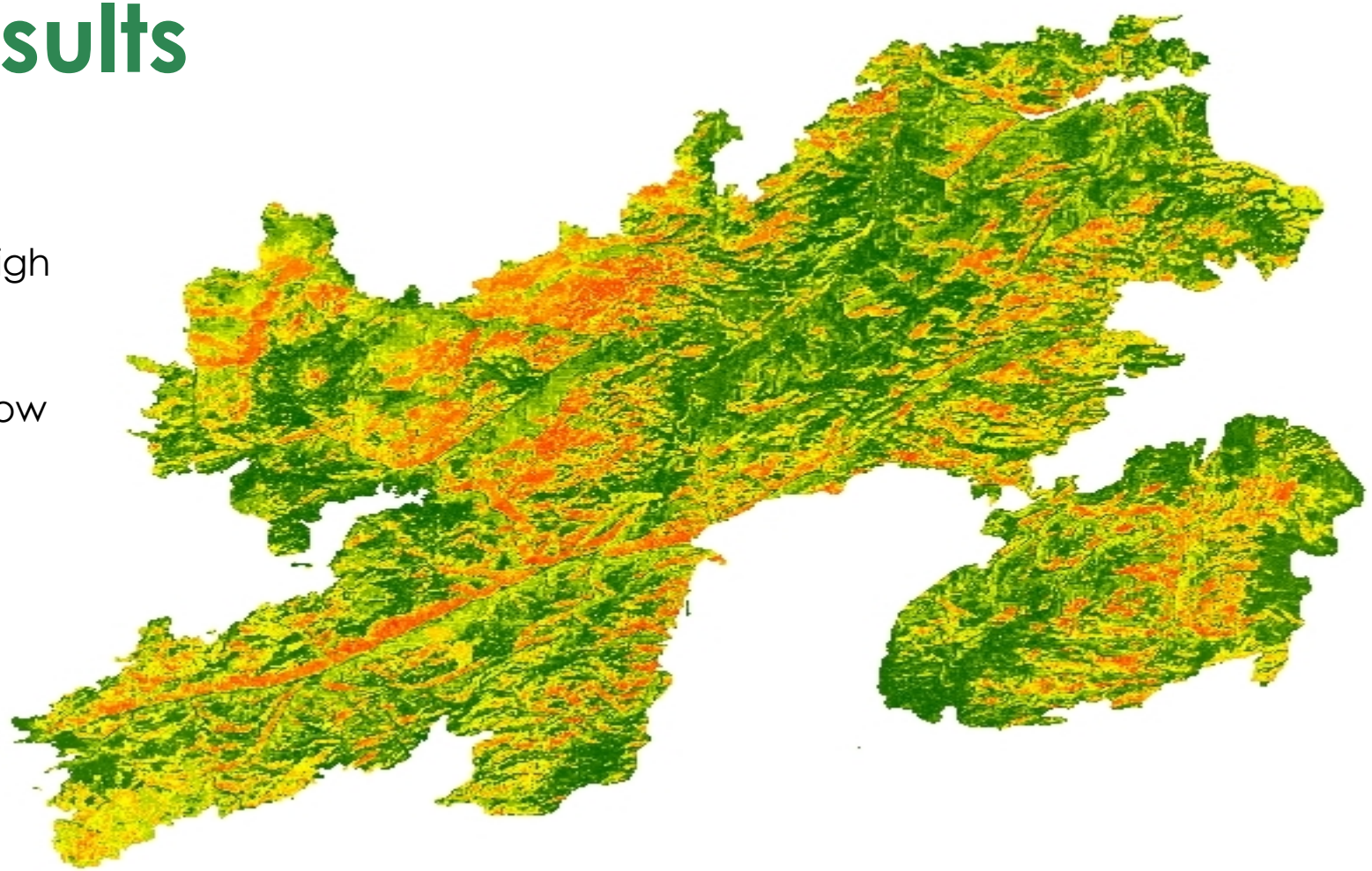

Zoom: 1d 5d 1m 3m 6m 1y Max Center Pixel 0.12 Average Pixel 0.14 | September 30, 2015
Pre-Fire EVI
Arapaho Fire
Post-Fire EVI
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2010
2012
2014
2009
2010
2011
2012
2013
2014
2015


Zoom: 1d 5d 1m 3m 6m 1y Max Center Pixel 0.11 Average Pixel 0.12 | September 30, 2015
Pre-Fire EVI
Arapaho Fire
Post-Fire EVI
0.4
0.3
0.2
0.1
-0.0
2010
2012
2014
2009
2010
2011
2012
2013
2014
2015

Results

High

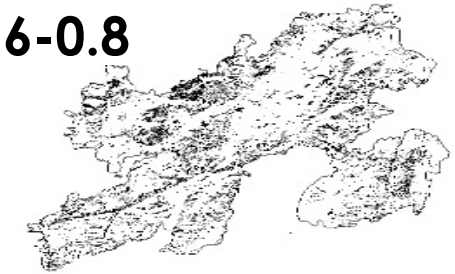
Low



0.4-0.6

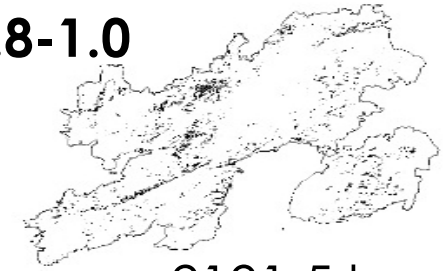
8862.93 ha

0.6-0.8



7495.56 ha

0.8-1.0



2191.5 ha

Errors and Uncertainties

Input Data

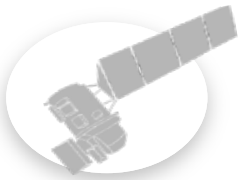
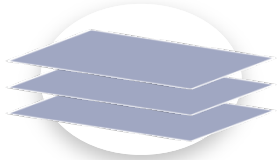
- **Cloud cover** and **snow**
- **Field data** from multiple years
- **Percent cover** threshold

Modeling

- Exploring **parameter values**
- **Binary classification** threshold

Phenology

- Phenology mapping after **recent fires**
- **Spatial & temporal resolution** of MODIS data

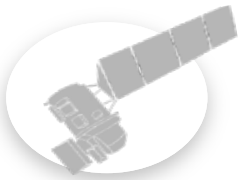
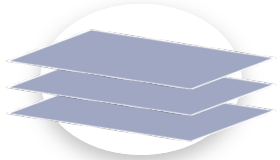
Conclusions

Cheatgrass Species Distribution Model

- Valuable **tool** for management
- Further **model refinement** needed

Final Products for Partners

- Cheatgrass **cover maps**
- Phenology **time series**

Questions?

Thank You!